

Notes

BRIEF contributions in any field of instrumentation or technique within the scope of the Journal can be accorded earlier publication if submitted for this section. Contributions should in general not exceed 500 words.

Laboratory Method for Preparation of Ferrite Rods

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MANY experiments with polycrystalline ferrites and garnets, as the measurements of the specific heat, the electrical and thermal conductivity, the thermal dilatation, and others, require relatively large, dimensionally true and mechanically strong rods, with circular or rectangular cross section. On the other hand, for microwave applications quite smaller shapes are mostly satisfactory. Those are easily obtained from die pressing followed by grinding and polishing in the desired shape. A serious limitation of die pressing arises in that the length of the sample may not be large compared to the other dimensions. The preparation of rods with die pressing, even with pressure applied from two directions and in vacuum gives rise to multiple fractures in the final sintering operation. In case of industrial preparation of tubes and rods, extrusion methods are preferred and also considerable lengths are easily obtained. This technique, however, requires a hydraulic extruder, which is usually not on hand in a common laboratory. We have found a satisfactory solution for this problem in the following way.

Conventional preparation methods¹ are applied to obtain the presintered oxide mixtures. Presintering is here important to help control shrinkage in the final shape. A minimal quantity of absolute ethyl alcohol (usually about 10% of the total weight) is mixed with the oxides to serve as a binder and a plasticizing agent. The plastic mass, obtained in this way, is pressed in the wanted shape in a steel mould. To obtain a maximum density, pressures up to 12.5 ton/cm² are applied by means of a hydraulic press. In view of reducing packing gradients, the pressure is applied from two directions with movable top and bottom punches. The central part of the mould is made of two pieces, exactly fitting together and strongly assembled by four bolts. On this central part are set up two removable cylindrical pieces in which the punches slide. To avoid fractures caused by suddenly releasing the pressed mass, an ejection mechanism as shown in Fig. 1 is used. The punches and the slide pieces are replaced on one side by the pushing-out system and on the other by a slide for the ejected rod. The

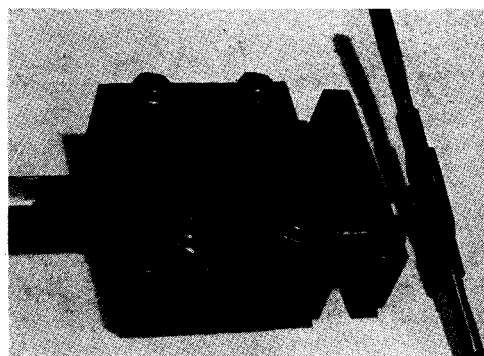


FIG. 1. Ejection mechanism for die press.

pushing-out system, attached to the mould, is composed of a steel ball, driven by a long screw which permits a progressive ejection. During this operation the gradual release of the pressed rod is assured by unscrewing the nuts progressively. A finely polished surface facilitates the ejection.

After the final sintering, mechanically strong rods of MgZn ferrite, MnZn ferrite, and YI garnet, with a length of 12 cm and a diameter of 1 cm are obtained. Their measured densities run up to 96% of the theoretical x-ray densities, and are, of course, a function of the applied pressure and the firing conditions.

Thanks are expressed to Professor Dr. J. L. Verhaeghe for his stimulating encouragement and to Mr. F. Bronck-aers, technician of this laboratory, for his careful construction.

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¹ D. L. Fresh, *Proc. Inst. Radio Engrs.* 44, 1303 (1956).

Pulse Characteristic Display for Tunnel Emission Devices

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RECENT studies on tunnel emission devices^{1,2} have demonstrated that destruction normally occurs because of high temperature generated within the thin film structure while their electrical characteristics are being measured. This difficulty has been overcome to a large degree by pulse tests performed with the unit described here. The most useful data to be observed on devices designed to emit electrons into a vacuum are: (a) the volt-ampere characteristic of the diode (metal-insulator-metal structure), and (b) the transfer characteristic (i.e., emitted current vs diode current).

The instrument shown in Fig. 1 displays both of these curves directly on the face of a Tektronix 502 oscilloscope either repetitively or for single pulse measurements. The scope is connected for X-Y dual beam operation and a

resistor across the horizontal input in series with the diode provides a horizontal deflection proportional to the diode current. Voltage across the diode is sensed by the lower beam differential input, hence the lower beam displays diode voltage versus diode current.

Vertical deflection corresponding to current emitted into the vacuum is provided by a load resistor coupled to the ac upper beam input. Hence the upper beam displays collected current versus diode current, the transfer characteristic.

In order to display these quantities for a pulse test, means must be provided for unblanking the scope and synchronously sweeping the current through the diode. Both of these functions are derived from the scope itself. By shunting the wiper of switch 5R (time base generator) to the -150-v supply (available on the adjacent terminal), the scope blanking function is retained in the X-Y mode. The sawtooth waveform from the time base generator (Pin 3, V 161 B) is fed to a cathode follower to act as a sweep source for the diode current. Various resistors in series with the cathode limit the maximum diode current to approximately 2, 20, and 200 ma for the three ranges. A well isolated 15-v battery in series with the grid holds the cathode follower below cutoff before the sweep is initiated. A G. E. type 7077 ceramic triode has proved quite satisfactory in handling the rather high current pulses involved with a quite good g_m . Sweep is initiated with a pulse from a $67\frac{1}{2}\text{-v}$ battery applied at the external trigger input with the trigger in the dc position. Pulse duration may be varied

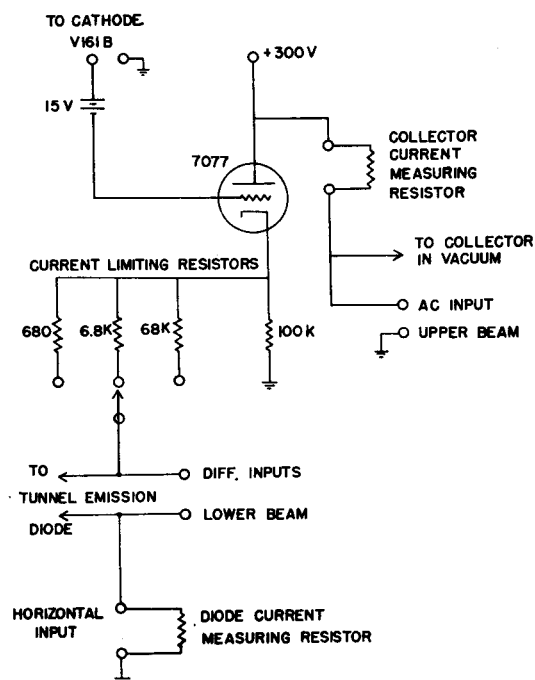


FIG. 1. Schematic diagram of test circuit used in conjunction with Tektronix model 502 dual beam oscilloscope.

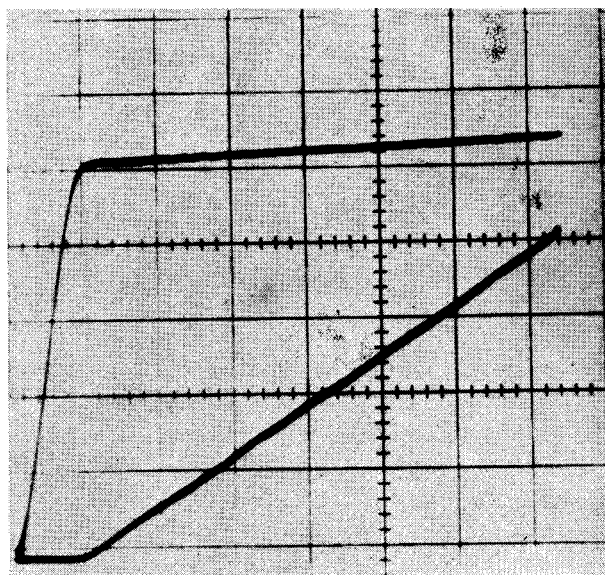


FIG. 2. Typical oscilloscope trace showing diode characteristic (upper curve) and transfer characteristic (lower curve) of tunnel-emission cathode.

by adjusting the sweep time/cm control. Continuous display at a 60-cycle rate may be obtained by setting the trigger selector to "line."

The unit described above has proven to be extremely versatile and easy to operate. All auxiliary circuitry and controls have been mounted on the scope-mobile upon which the 502 is carried and may be easily rolled to the vacuum system where the tests are being done. A typical data photograph taken with a Tektronix camera on this apparatus at $2\text{ }\mu\text{sec/cm}$ is shown in Fig. 2.

¹ C. A. Mead, *Proc. Inst. Radio Engrs.* **48**, 359 (1960); **48**, 1478 (1960).

² C. A. Mead, *J. Appl. Phys.* **32**, 646 (1961).

Production of Small Spheres from Suspensions of Micropowders*

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A STUDY of the ferrimagnetic resonance phenomena of $\gamma\text{-Fe}_2\text{O}_3$ powders with particle sizes in the micron or submicron range has been carried out in this laboratory.¹ For this investigation it was necessary to produce spherical samples of suspensions of these powders in Lucite or paraffin wax. This required the development of grinding techniques other than the familiar air-blast method.

In order to suspend the iron-oxide powders in Lucite, Lucite powder and iron-oxide powder were mixed in the desired proportion. Then acetone, which dissolves the